International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249–6890; ISSN (E): 2249–8001
Vol. 9, Issue 6, Dec 2019, 365–376

AN EXPERIMENTAL STUDY TO DETERMINE THE COP OF THE DOMESTIC REFRIGERATOR WHEN THE PROPANE BUTANE COMBINATION ADDED TO LPG

KHASIM SHARIF SK, K. RAJANIKANTH & SHANKARLINGA B. SHIKKERI

Assistant Professor, Department Mechanical Engineering, CMR Technical Campus, JNTUH, Hyderabad, India

ABSTRACT

This research examines the results from an experimental study to accomplish the household refrigerant coefficient of performance, when the propane-butane mixture introduced to an affordable liquefied petroleum gas (LPG). The paper also discussed the impact on refrigerant in the adiabatic helical capillary tube on the effects of the capillary tube size, the inner diameter of the capillary tube and capillary coil diameter. In underdeveloped countries such as India, significant amounts of power supply are not easily accessible. LPG is the stronger appreciated and environmental safe, with no ozone depletion potential (ODP). It works in distant areas such as test sites, mines and grasslands, where usually no energy is accessible. In local refineries, the LPG is obtainable as a side product. The outcomes of present research exposed that, this propane-butane mixture is used effectively in domestic refrigerator as an optimal replacement for CFCs and HFCs. The experimentation model was configured, and the LPG cooler thoroughly studied, which was to be deployed in refineries, restaurants, and the chemical industry with the increased supply for LPG. The refrigerant effect is 267.66 KJ/Kg, and the coefficient of performance is 6.4

KEYWORDS: Global Worldwide Warming, COP, Liquefied Petroleum Gas & Ozone Depletion Potential

Received: Sep 27, 2019; **Accepted:** Oct 18, 2019; **Published:** Oct 30, 2019; **Paper Id.:** IJMPERDDEC201931

Original Article

1. INTRODUCTION

The decline of energy continues throughout the globe. The idea is to restore the energy already lost, but not used to fix this crisis without any enormous investments [1]. The Global environment transformation calls for affordable and cheap heating techniques in the form of refrigerants and air-conditioners [2-4]. Billions of dollars worldwide are spent to achieve this goal, which recommend that petroleum gas is put before use for non-cost cooling systems as a fuel in a liquefied state. The energy invested in storing and liquefying is subsequently not recovered [3-8]. Due to its outstanding thermodynamic and thermo-physical characteristics, more than 80 % of the house refrigerator in India utilises HFC 134a as a refrigerant. HFC 134a, indeed, has significant Global worldwide warming (GWP) [9-10]. For this, different cooling alternatives must be evaluated concerning contemporary coolers for the future market. CFCs are mainly destroyed by ultraviolet (UV) radiation in the stratosphere; ozone released to oxygen decomposition by Chlorine in the raised stratosphere and UV radiation infiltrated at lower altitudes [13]. The ozone effects of automotive air conditioners are also hard to overlook. Hydrofluorocarbons (HFCs) can be regarded as substitutes, but surprisingly, their radioactive characteristics are potent global warming inhibitors for HFCs such as r-134a [14–17]. It was replaced with the HFC 134a and HC 12 blend because of their inconveniences in the effectiveness of systems, their flammability and their capacity for service [8]. HFC 134a with mineral oil is not biologically inert; therefore, it is recommended to use ploy ester oil with highly hygroscopic effects. LPG is a mix

of natural butane and natural propane and unsaturated hydrocarbons. LPG sold in India is governed by the Indian Standard Code IS-4576 and the test method IS-1448. There is strong evidence that any potential refrigerant has high molar heat capacities in large molecules, which will result in less thermodynamic efficiency. If the supply of refrigerants is under no regulation, the market will remain dominated by the use of hydrofluorocarbon refrigerants. For selected applications, natural coolants can gain market share. The search for new and advanced technology must continue to produce sustainable solutions for the future.

The unadulterated refrigerant that complies with all these necessities is currently acceptable. Additionally, the desired work fluid can be obtained by combining two or more pure refrigerants to reduce the undesirable properties of pure refrigerants by dilution [11]. The refrigerant mixtures are the most excellent substitute to pure fluids that only fulfil part of a necessary refrigerant's intended properties. The numerical simulation has proven to be an influential tool used widely for forecasting performance and optimising refrigerant cycles [12]. However, people in those regions still need heating and air conditioning for a variety of socially important reasons, including the use of LPG instead of electric for cooling, as well as human comfort air conditioning for cold storage or the storage of medical supplies and domestic kitchen. For regions of energy scaring, this solution is useful for refrigeration. GPL is a petroleum by-product with a very low boiling point (less than 0oC) of 24.4% propane, 56.4% butane and 17.2% isobutene. It is grounded on the principle that the expansion of LPG takes place when LPG is transformed into gaseous form. As a part of this expansion, the demand is decreasing and the volume of LPG increases, leading to a decrease in temperature and a cooling effect [13].

The cooling effect can be used for heating and also for air conditioning. This system, therefore, offers a culturally relevant air conditioning effect and replaces refrigerant generators for global warming. During its review of the literature in the LPG refrigeration system, traditional VCR (Vapour compression cooling system) uses LPG as a refrigerant and produces the cooling effect. Nevertheless, in projected work, the fundamental method of refrigeration system in which, the LPG enters a capillary tube and extends. The step of expansion of LPG is turned from liquid to gas and then the evaporator is moved through, where, heat is consumed and cooled.

2. LPG PHYSICAL PROPERTIES AND CHARACTERISTICS

2.1 Density

LPG is twice most massive than air at atmospheric temperature and pressure, and it effortlessly liquefies under mild pressure. The density of liquid amounts to about half the volume of water from 0.525 up to 0.580, at 15 ^{0}C, since LPG is thicker than the air, and is generally depressed at the ground and steep-lying places.

2.2 Vapour Pressure

In an LPG storage cylinder, the pressure within the tank equals the vapour pressure that corresponds to the LPG temperature. The vapour pressure relies on the temperature and the hydrocarbon blend percentage. When the gas expands completely, the cylinder pressure rises by about 13 to 14 kg./sq. cm for 10^{0}C, any other liquid expansion, it defines the hazardous situation that can happen due to excess cylinders.

2.3 Flammability

Liquid Petroleum Gas does have an exothermic range of 1.6 % to 9 % of the quantity of gas in the atmosphere and is considerably smaller than most other familiar gaseous energy sources. In the low lying area, flammability shows that the

LPG vapour in the case of leakage or discharge may accumulate. The auto-ignition temperature of LPG is about 41^0C -58^0C and does not spark on its own at a standard temperature. During pumping, the trapped air in the steam, which is not purged the cylinder, is hazardous. In this context, air pressure for unloading LPG tankers is not recommended.

2.4 Odour

LPG does have a feeble smell, so that any running out of control gas can be easily recognised, and it is vital to add a particular oxidising agent. For this purpose, Ethyl Mercaptan is typically used as a reinforcing agent. The quantity changes should be adequately retained in order to identify the decreased flammability rate 2 in atmosphere 1/5 as per IS 4576.

2.5 Combustion

The combustion process of LPG increases the quantity of heat generation. LPG requires up to 50 times its air volume for full combustion. Therefore, adequate ventilation is needed if LPG is burnt in concealed areas or asphyxiation may occur, apart from an accumulation of carbon dioxide happens, due to oxygen depletion.

2.6 Colour

For liquid and vapour stages, LPG is colourless. The vaporisation cools the atmosphere while leaking and condenses the water vapour it contains to produce white smog.

2.7 Toxicity

LPG in the vapour stage is not poisonous, albeit mildly toxic, yet can suffocate in substantial amounts due to the oxygen displacement. Because of this, the steam has mild an aesthetic features.

2.8 Hazards of LPG

- The LPG is about twice as dense as air when it is gas-shaped and typically reduced to the lowermost level possibly.
- Due to its rapid vaporisation, LPG in liquid form may reason to severe cold burns on the skin.
- Vaporisation can cause cold burns in cool devices, so that warm burns prevented.
- At concentrations between 2% and 10 %, LPG forms an inflammable mixture with water.
- If stored or misused, it can be a fire and explosion hazard.
- Mixtures of vapour/air resulting from leaks can be found some distance from the escape point, and fires can return to the leak source.
- Vapour is an aesthetic and subsequently asphyxiated by diluting the oxygen available at very high concentrations when mixed with air.
- A vessel containing LPG is nominally empty; however, it may still have LPG vapour and may be harmful. Therefore, treat all LPG vessels as complete.

3. LPG REFRIGERATION SYSTEMS DESIGN AND THE BASIC COMPONENTS

3.1 The Capillary Tube

The capillary tube is a solid device, like a long, tight tube, that binds the condenser directly to the evaporator. Because of the following two friction parameters, the pressure flow through the capillary tube results in flashing of the liquid refrigerant into the vapour, consequential in a decreasing friction pressure and an acceleration. The tube has a small inner copper tube with an inner diameter 1.05mm. It is lengthy and spiralling in several directions to take up less volume. For cooling applications, the inner diameter of the capillary tube varies between 0.5mm to 2.5 mm. The prevention of coolant pressure through capillary relies on the diameter and capillary length of the capillary. The diameter is smaller, and the capillary is more distant than the refrigerant's pressure drop when it passes via the capillary tube. Design parameters for the capillary tube are

Length of the tube = 295 mm;

Día of capillary = 1.05mm

Figure 1: Capillary Tube.

3.2 Evaporator

When the cooling effects happen during the drying cycle, the evaporators in the cooling system produce the cooling impact. The evaporators are units that exchange the heat from the cooling material and thus take the heat off the medium. After passage through the capillary tube at low pressure and temperature, the coolant reaches the evaporators. This refrigerant captures the moisture from the cooling substance so that the refrigerant is heated during the cooling process. The refrigerant from the evaporator is even lower than the evaporator used by cooling water plants.

Figure 2: The Evaporator.

3.3 Pressure Gauge

The Bourdon pressure gage is the best regularly utilised mechanical gauge. It is a stiff, flattened, curved steel tube. The fluid flows inside the tube, which must be evaluated by pressure. The side of the tube is fixed, and the other end is to move freely to or from within. The free-end movement inside and outside has a pointer. The indicator displays the pressure of the indicator (the difference between fluid and ambient pressure). These measurements can be accessed in different pressures.

Figure 3: Pressure Gauge.

3.4 High Pressure Pipes

The scope of high-pressure pipes encompasses many applications, where high-pressure gas transmission specifications occur. They contain a steel pipe fitted on both ends with a steel ball. The balls pressed by two swivelling connection nipples against the whole connecting seat, and thus sealing contrary to gas leak all pipes measured with recommended working pressure at 100 MPa (14,500 psi).

Figure 4: High-Pressure Pipe.

3.5 High-Pressure Regulator

The regulator used for sending high-pressure gas out of the cylinders, construction of an LPG refrigerant.

Figure 1: High-Pressure Regulator.

4. EXPERIMENTAL SETUP

The LPG refrigerant operates with the vapour compression cooling mechanism. The simple idea after the LPG refrigerant is the use of LPG for heat absorption. Whenever the control gas tank is unlocked, the LPG placed under high pressure in the LPG cylinder where LPG passes through the high-pressure tube. The LPG high-pressure tube transformed with the remaining enthalpy constant at low pressure.

Figure 6: Working of an LPG Refrigerant.

The low-pressure LPG refrigerant flows through the evaporator after the tube. The capillary tube translated into the capillary tube through the LPG. The LPG is transformed into small pressure vapour and processes to the evaporator that absorbs heat in the chamber, making it comfortable and cooling the refrigerant. The LPG passes through the pipe to burner after passing through the evaporator. The VCR system goes as follows.

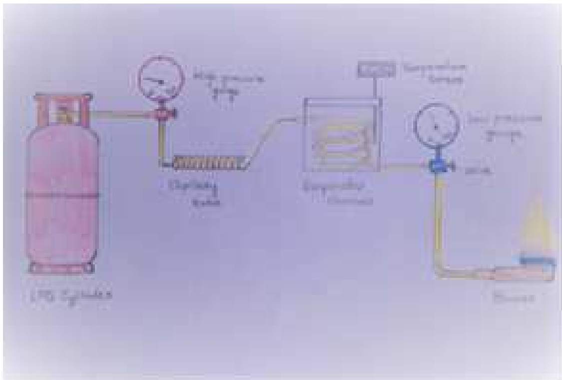

Figure 7: LPG Refrigeration and Heating System.

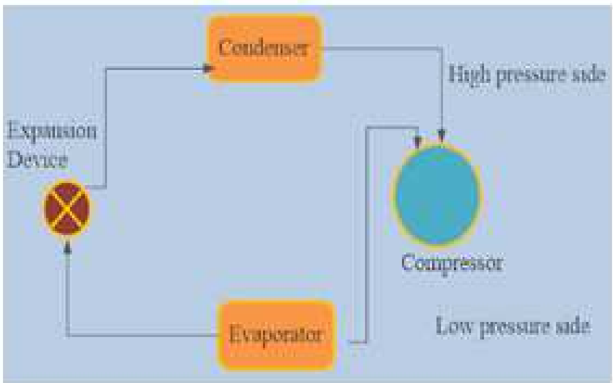

Figure 8: Vapour Compression Refrigeration System.

4.1 ADVANTAGES AND DISADVANTAGES

4.1.1 Advantages

- The usage of LPG as a refrigerant also increases the overall performance by between 10% and 20 %.
- LPG's ODP is zero, and GWP is 8, which in contrast with other refrigerant is substantially negligible.
- The system's weight reduced by 60% because of LPG lower capacity.
- If power is off, this refrigerator works.
- Besides being environmentally friendly, LPG use also has many advantages in terms of costs.
- The components are quiet during service.
- The Price of operation is zero.

4.1.2 Disadvantages

- Efficiency is ineffective.
- LPG leak triggers the explosion.
- The system is difficult to repair and manage.
- The system is a vast Structure.

5. RESULTS AND DISCUSSIONS

5.1 Experimental Values

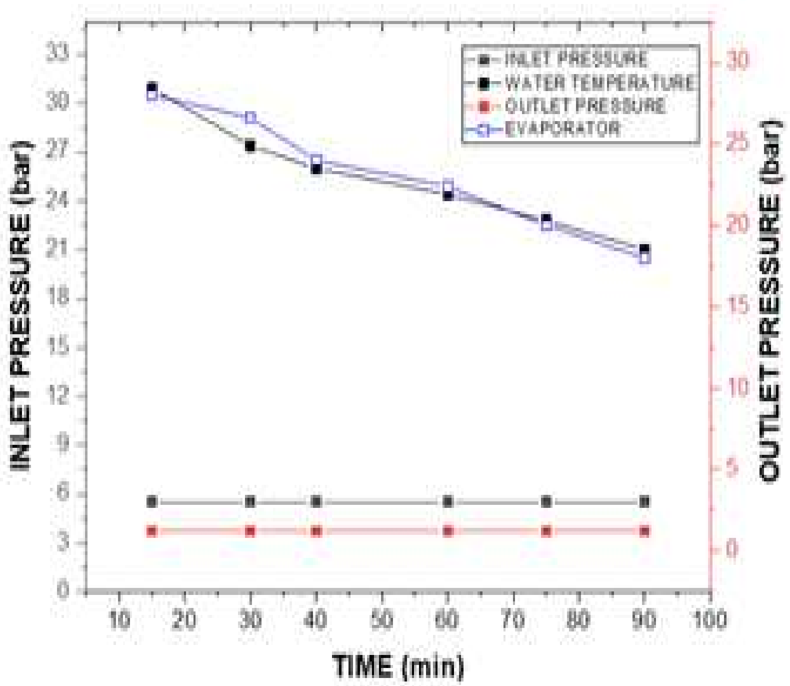

Figure 9: Time vs. Pressure (Outlet Pressure and Inlet Pressure).

5.2 COP of an LPG Refrigeration System

At 5.525 bar LPG Enthalpy is (h) = 430.3 kJ/Kg;

At 1.22 bar LPG Enthalpy is (hf) = 107.3 kJ/Kg;

Saturation Temperature tsat= -30 ^{0}C

The heat removed from evaporator in 1.5 hours (Qeva) = Heat Absorption by LPG (QLPG)

(Qeva) = Heat absorption from (water + surrounding air inside of evaporator + leakage)

Mass of water (mw) =1kg; (ΔT) W =10^{0}C

The Specific heat of water (Cpw) =4180J/Kg. K

Dryness fraction of LPG from the graph (XLPG) =0.5

(Q) = Qeva + Qair +QL= mwCPw (ΔT) + maCpa (ΔT) +QL

1 kg of a water bottle taken, hence there is less amount of air, so = 41800 J.

Heat absorbed by (QLPG) Liquid petroleum Gas = Sensible heat gain (QSen) LPG +Latent heat absorbed (QL) LPG;

The volume flow rate (LPG) is 0.1 liter per min;

The Cv of LPG at 1.22 bar pressure is 1.763×10-3 m3/Kg.;

Hence, the mass flow rate (LPG) = 0.0001/1.763×10-3 = 0.0567 Kg/min; m = 9.448×10-4Kg/sec

=cpLPG. (Tsup-Tsat) + mLPG x LPG. hfg mLPG

= 9.448×10-4×1.67×(48) +9.448×10-4×0.5×375×103×5400= 0.956812 MJ/hr.

h2 = X. hfg+hf= 0.5 x 375+107.3 = 294.8 KJ/Kg

hg = hfg+ hf = 375+107.3= 482.3 KJ/Kg.

h3 = hg + Cp. ΔT = 481.3 + 1.66 x 48 = 563.46 KJ/Kg;

The refrigerating effect (RE) = h3 – h2 = 562.46 – 294.8 = 267.66 KJ/Kg

The work input was needed to calculate the COP of the system. Input 14.5 kg for the LPG cylinder was chosen. Therefore, the quantity of energy needed to fill a single-cylinder was the quantity of power input required. The power needed for refilling a tank from the PCRA energy inspection study is 3,1354kWh. Hence, to fill one kg of the LPG cylinder, the power required is = 3.2354/14.5 = 0.2262 kWh;

The 1.50 hr. power is set up = 0.2262×1000/ (9.45/10000) ×5400 = 43.49W

COP = (h3-h2)/W = 267.66/43.49 =6.4

6. CONCLUSIONS

- The LPG, fitted with an elevated pressure regulator, has a pressure of 12.41 bar on the domestic cylinder 14.5 kg, which was lowered to 14.1 bar employing the capillary tube.
- The COP of the LPG refrigeration system with this energy intake is 6.3, and is larger than the domestic cooler.
- In the future, however, the result may vary from the energy audit of any refinery if energy input for 1 Kg of LPG production was taken.

- At both original and operating costs, this model is cheaper.
- No external energy sources and no moving part of the system required for the system.
- Maintenance costs are therefore also minimal. This model is best suited for the restaurant, industry, the factory, chemical sectors with very high LPG usage.

REFERENCES

1. *Baskaran, A., & Mathews, P. K. (2012). A Performance comparison of vapour compression refrigeration system using Eco-friendly refrigerants of low global warming potential. International journal of scientific and research publications, 2(9), 1–8.*
2. *El-Morsi, M. (2015). Energy and exergy analysis of LPG (liquefied petroleum gas) as a drop-in replacement for R134a in domestic refrigerators. Energy, 86, 344–353.*
3. *Patel, P. Y., Sathvara, V. S., Raval, S. A., Shaikh, A. G., & Parikh, K. Model of LPG Refrigerator: A Literature Review. International Journal of Advanced Engineering Research and Science, 4(1).*
4. *Bolaji, B. O. (2010). Experimental study of R152a and R32 to replace R134a in a domestic refrigerator. Energy, 35(9), 3793–3798.*
5. *James, R. W., & Missenden, J. F. (1992). The use of propane in domestic refrigerators. International journal of refrigeration, 15(2), 95–100.*
6. *Ghariya, V. J., & Patel, C. R. (2015). Thermodynamically Evolution of LPG Refrigerator in Mobile Refrigerator. International Journal of Scientific Research in Science, Engineering and Technology, 1(3), 135–141.*
7. *Rai, A. K., Kumar, A., Kumar, P., & Ansari, A. A. (2015). Experimental Study on A Domestic Refrigerator Using Lpg As A Refrigerant. Technology, 6(11), 43–49.*
8. *Shah, S. M. R. D., Bhansali, S. S., Nichat, V. S., & Jaisingpure, S. D. (2018). A review: Design and fabrication of LPG as the refrigerant in AC and working fluid in a burner. International Journal of Electronics, Communication and Soft Computing Science & Engineering (IJECSCSE), 59–63.*
9. *Austin, N., Kumar, P. S., & Kanthavelkumaran, N. (2012). Thermodynamic optimisation of household refrigerator using propane-butane as the mixed refrigerant. International Journal of Engineering Research and Applications, 2(6), 268–271.*
10. *Udchan, v., (2018). Lpg refrigeration system with zero operating cost (doctoral dissertation, visvesvaraya technological university).*
11. *Rasti, M., Aghamiri, S., & Hatamipour, M. S. (2013). Energy efficiency enhancement of a domestic refrigerator using R436A and R600a as alternative refrigerants to R134a. International Journal of Thermal Sciences, 74, 86–94.*
12. *Russo, G., Anifantis, A. S., Verdiani, G., & Mugnozza, G. S. (2014). Environmental analysis of geothermal heat pump and LPG greenhouse heating systems. Biosystems Engineering, 127, 11–23.*
13. *Yu, C. C., & Teng, T. P. (2014). Retrofit assessment of refrigerator using hydrocarbon refrigerants. Applied thermal engineering, 66(1-2), 507–518.*
14. *Fatouh, M., & El Kafafy, M. (2006). Experimental evaluation of a domestic refrigerator working with LPG. Applied Thermal Engineering, 26(14-15), 1593–1603.*
15. *He, Y. & Chen, G. (2007). Experimental study on an absorption refrigeration system at low temperatures. International Journal of Thermal Sciences, 46(3), 294–299.*

16. Naik, R. T., & Nilesh, C. (2016). Emission characteristic of a high speed diesel engine. International Journal of Mechanical Engineering, 5, 29–36.

17. Kim, M. S., Mulroy, W. J., & Didion, D. A. (1994). Performance evaluation of two azeotropic refrigerant mixtures of HFC-134a with R-290 (propane) and R-600a (isobutane). Journal of energy resources technology, 116(2), 148–154.

18. Mohanraj, M., Jayaraj, S., Muraleedharan, C., & Chandrasekar, P. (2009). Experimental investigation of R290/R600a mixture as an alternative to R134a in a domestic refrigerator. International Journal of Thermal Sciences, 48(5), 1036–1042.

19. Mohanraj, M., Jayaraj, S., & Muraleedharan, C. (2009). Environment-friendly alternatives to halogenated refrigerants—A review. International Journal of Greenhouse Gas Control, 3(1), 108–119.

20. Fatouh, M., & El Kafafy, M. (2006). Experimental evaluation of a domestic refrigerator working with LPG. Applied Thermal Engineering, 26(14-15), 1593–1603.

21. Halimic, E., Ross, D., Agnew, B., Anderson, A., & Potts, I. (2003). A comparison of the operating performance of alternative refrigerants. Applied thermal engineering, 23(12), 1441–1451.

22. He, Y. & Chen, G. (2007). Experimental study on an absorption refrigeration system at low temperatures. International Journal of Thermal Sciences, 46(3), 294–299.

23. Colonna, P., & Gabrielli, S. (2003). Industrial trigeneration using ammonia-water absorption refrigeration systems (AAR). Applied Thermal Engineering, 23(4), 381–396.

24. Rogdakis, E. D., & Antonopoulos, K. A. (1992). Performance of a low-temperature NH3 H2O absorption-refrigeration system. Energy, 17(5), 477–484.

25. Dhamneya, A. K., Rajput, S. P. S., & Singh, A. L. O. K. (2017). Theoretical performance analysis of octagon configuration as cooling media in direct evaporative cooling. International Journal of Mechanical and Production Engineering Research and Development, 7(1), 23–34.

26. Thioye, M. (1997). Performance improvement of absorption cooling systems by using staged absorption and desorption cycles. International Journal of Refrigeration, 2(20), 136–145.

27. Wang, J. F., Gao, G. C., & Chen, G. M. (2000). An improved absorption refrigeration cycle is driven by unsteady thermal sources below 100° C. International Journal of Energy Research, 24(7), 633–640.

28. Venegas, M., Izquierdo, M., De Vega, M., & Lecuona, A. (2002). Thermodynamic study of multistage absorption cycles using low‐temperature heat. International Journal of Energy Research, 26(8), 775–791.

29. Misra, R. D., Sahoo, P. K., & Gupta, A. (2005). Thermoeconomic evaluation and optimisation of a double-effect H2O/LiBr vapour-absorption refrigeration system. International Journal of Refrigeration, 28(3), 331–343.

30. Kilicarslan, A., & Müller, N. (2005). A comparative study of water as a refrigerant with some current refrigerants. International journal of energy research, 29(11), 947–959.

31. Anderko, A., & Young, R. D. (2000). Model for corrosion of carbon steel in lithium bromide absorption refrigeration systems. Corrosion, 56(5), 543–555.

32. Srikhirin, P., Aphornratana, S., & Chungpaibulpatana, S. (2001). A review of absorption refrigeration technologies. Renewable and sustainable energy reviews, 5(4), 343–372.

33. He, Y. & Chen, G. (2007). Experimental study on an absorption refrigeration system at low temperatures. International Journal of Thermal Sciences, 46(3), 294–299.

34. Borde, I., Jelinek, M., & Daltrophe, N. C. (1995, August). Working substances for absorption heat pumps based on R32. In Proceedings of the 19th International Congress of Refrigeration, The Hague, Netherlands (Vol. 4, pp. 80–7).
35. Borde, I., Jelinek, M., & Daltrophe, N. C. (1997). Working fluids for an absorption system based on R124 (2-chloro-1, 1, 1, 2,-tetrafluoromethane) and organic absorbents. International Journal of Refrigeration, 20(4), 256–266.
36. Jelinek, M., & Borde, I. (1998). Single-and double-stage absorption cycles based on fluorocarbon refrigerants and organic absorbents. Applied Thermal Engineering, 18(9-10), 765–771.
37. Jelinek, M., & Borde, I. (1999). Working fluids for absorption heat pumps based on R125 (pentafluoroethane) and organic absorbents. In International Sorption Heat Pumps Conference, Munich (pp. 205–8).
38. Levy, A., Jelinek, M., Borde, I., & Ziegler, F. (2004). Performance of an advanced absorption cycle with R125 and different absorbents. Energy, 29(12–15), 2501–2515.
39. He, Y., Chen, G., & Meng, X. (2003). Experimental study on a new absorption refrigeration system using R134a+ 32/DMF. In Proceedings of the 5th Minsk International Seminar "Heat Pipes, Heat Pumps, Refrigerators", Minsk, Belarus (pp. 315–319).
40. Babu, D. R., Rao, K. N., Kumar, M. S., & Kumar, B. S. (2018). Handling of apples during sorting-grading operation and measuring the mechanical properties firmness after controlled atmosphere storage. International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) December.
41. He, Y., Hong, R., & Chen, G. (2005). Heat driven refrigeration cycle at low temperatures. Chinese Science Bulletin, 50(5), 485–489.
42. Zhong, Y., & Chen, G. (2004). Theoretical and Experimental Study of a New Absorption Refrigeration Cycle. ASHRAE Transactions, 110(1).
43. He, Y., Zhu, Z., Gao, X., & Chen, G. (2012). Study on a Novel Absorption Refrigeration System at Low Cooling Temperatures.
44. Peng, D. Y., & Robinson, D. B. (1976). A new two-constant equation of state. Industrial & Engineering Chemistry Fundamentals, 15(1), 59–64.

AUTHOR'S PROFILE

Mr. Khasim Sharif. SK, Completed B.Tech degreein Mechanical Engineering (2009) JNTU University and Master Degree in computer aided Design and Manufacturing (2011) at JNTUH University, Hyderabad. He had 10 years of teaching experience. The interested research works include Thermal Engineering, CAD/CAM and Machine Design. The proficient software's known are Ansys and Auto CAD/CAM. Presently working as Asst.Prof. in Mechanical Engineering department at CMR Technical Campus, Hyderabad, India.

Mr. K.Rajanikanth, Completed B.Tech degreein Mechanical Engineering (2002) JNTUH University and Master Degree in computer aided Design and Manufacturing (2015) at JNTUH University, Hyderabad. He had 14 years of teaching experience. The interested research works include Thermal Engineering, CAD/CAM and Machine Design. The proficient software's known are Ansys and Auto CAD/CAM. Presently working as Asst.Prof. in Mechanical Engineering department at CMR Technical Campus, Hyderabad, India.

Mr. Shankarlinga B Shikkeri, Completed B.E degreein Mechanical Engineering (2013) at GEC Raichur, Karnataka and Master Degree in Product Design and Manufacturing (2015) at PG centre, VTU, Belagavi, Karnataka He had 4 years of teaching experience. The interested research works include Composite materials, Material science and Metrology. The proficient software's known are Solid Edge, Ansys and Fusion 360. Presently working as Asst.Prof. in Mechanical Engineering department at CMR Engineering College, Hyderabad, India.